Lecture Module - Sensors

ME3023 - Measurements in Mechanical Systems

Mechanical Engineering

Tennessee Technological University

Module 4 - Sensors

Module 4 - Sensors

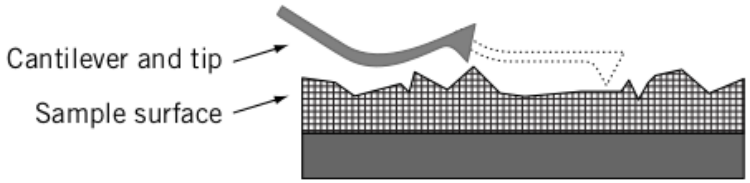
- Topic 1 - Introduction and Overview
- Topic 2 - IC and MEMS based Sensors

Topic 1 - Introduction and Overview

- Classification of Sensors
- Analog and Digital Sensors
- Example 1: Distance or Range
- Example 2: Rotation

Classification of Sensors

a sensor, a physical element that employs some natural phenomenon... ...to sense the variable being measured



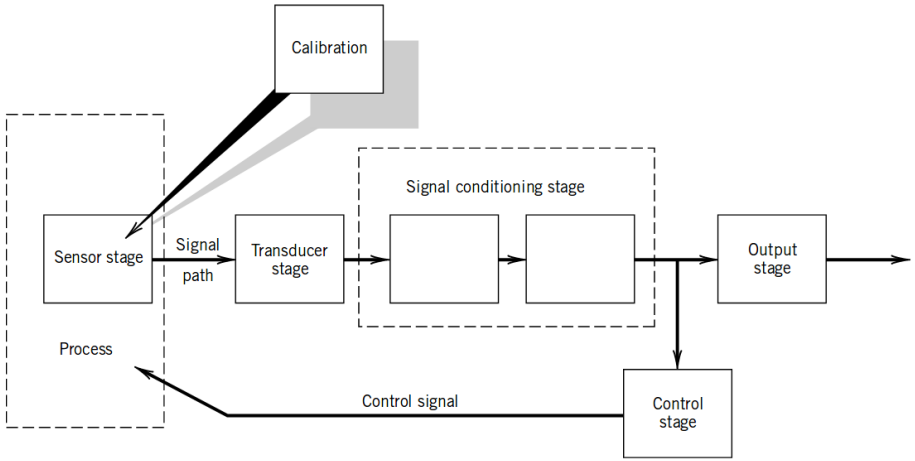


Figure 1.5 Components of a general measurement system.

Image: Theory and Design of Mech. Meas.

Classification of Sensors

Analog and Digital Sensors

Analog	Digital	Both?

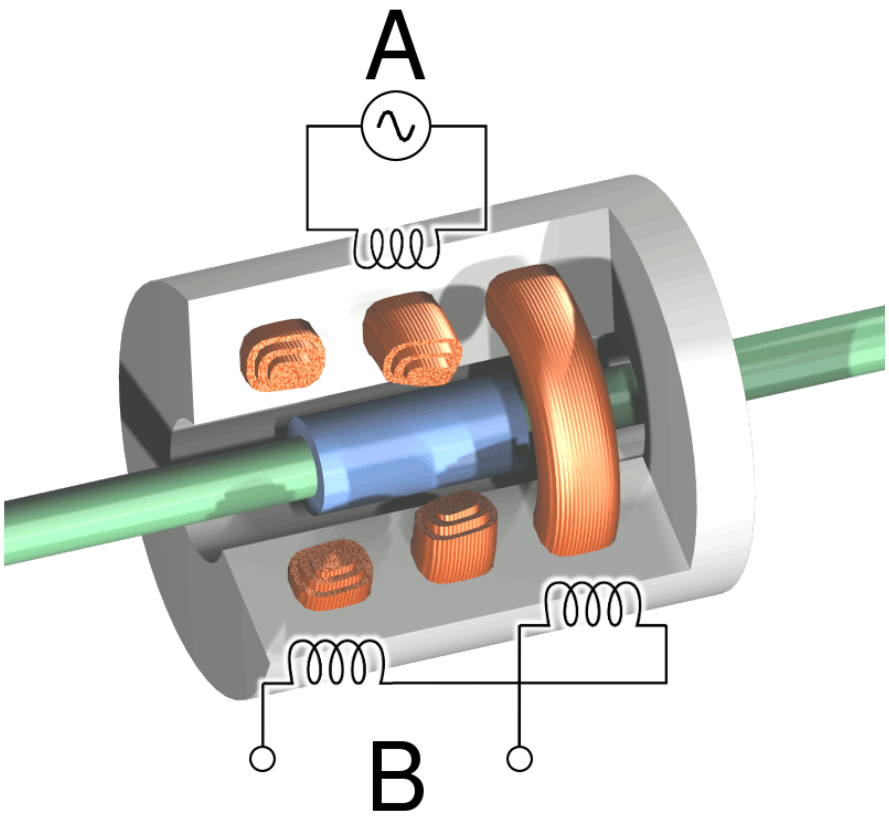
Analog and Digital Sensors

Analog and Digital Sensors

Example 1: Distance or Range

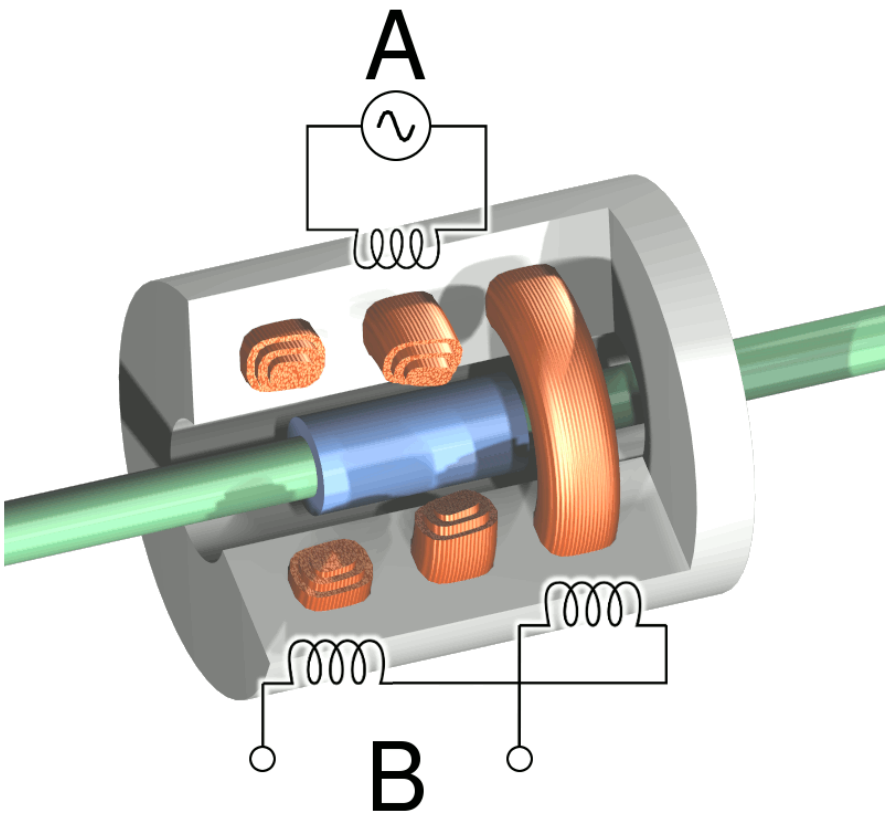
Thought Exercise: How do we measure distance (aka range)?

Example 1: Distance or Range



LVDTs with NI
LVDT Animation

Example 1: Distance or Range



Example 2: Rotation

Thought Exercise: How do we measure rotation?

- What variable or quantity is used to describe rotation?
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  -
- What type of sensor is used to measure this?
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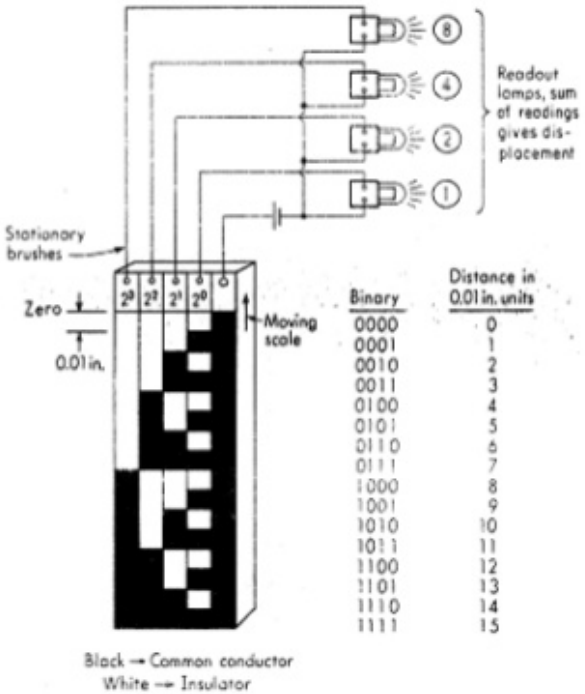
Example 2: Rotation

Rotational Potentiometer

Example 2: Rotation

Absolute Encoder

4-Bit Binary Optical Absolute Encoder Disk



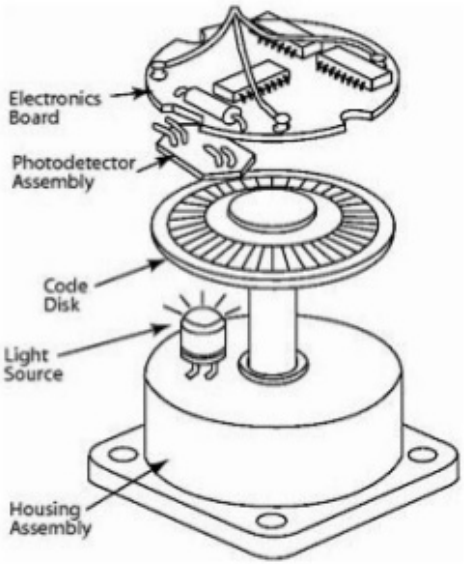
Binary	Distance in 0.01 in. units
0000	0
0001	1
0010	2
0011	3
0100	4
0101	5
0110	6
0111	7
1000	8
1001	9
1010	10
1011	11
1100	12
1101	13
1110	14
1111	15

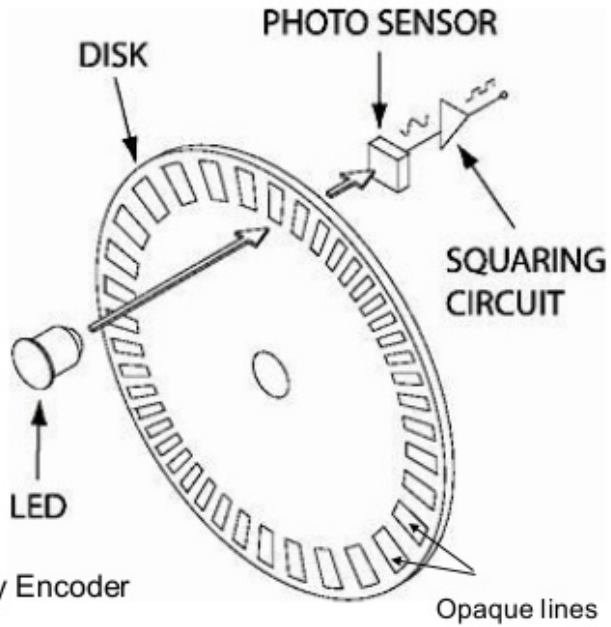
Example 2: Rotation

Incremental Encoder

2. Types of Rotary Encoder - Incremental

Construction of Incremental Rotary Encoder





Components inside Incremental Rotary Encoder

Example 2: Rotation

- What applications require this type of sensor?
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  -
  -

Example 2: Rotation

- How does this type of sensor work?
  -
  -
  -

Example 2: Rotation

Thought Exercise: How do we measure orientation?

- What variable or quantity is used to describe orientation?
  -
  -
  -
- What type of sensor is used to measure this?
  -
  -
  -

Example 2: Rotation

- What applications require this type of sensor?
  -
  -
  -

Example 2: Rotation

- How does this type of sensor work?
  -
  -
  -

Topic 2 - IC and MEMS based Sensors

- Integrated Circuits
- Micro Electro-Mechanical Devices
- Example 1: Magnometer and Digital Compass
- Example 2: Accelerometer

Integrated Circuits

Actvitity: Group Brainstorming

List three applications or devices that use IC based sensors.

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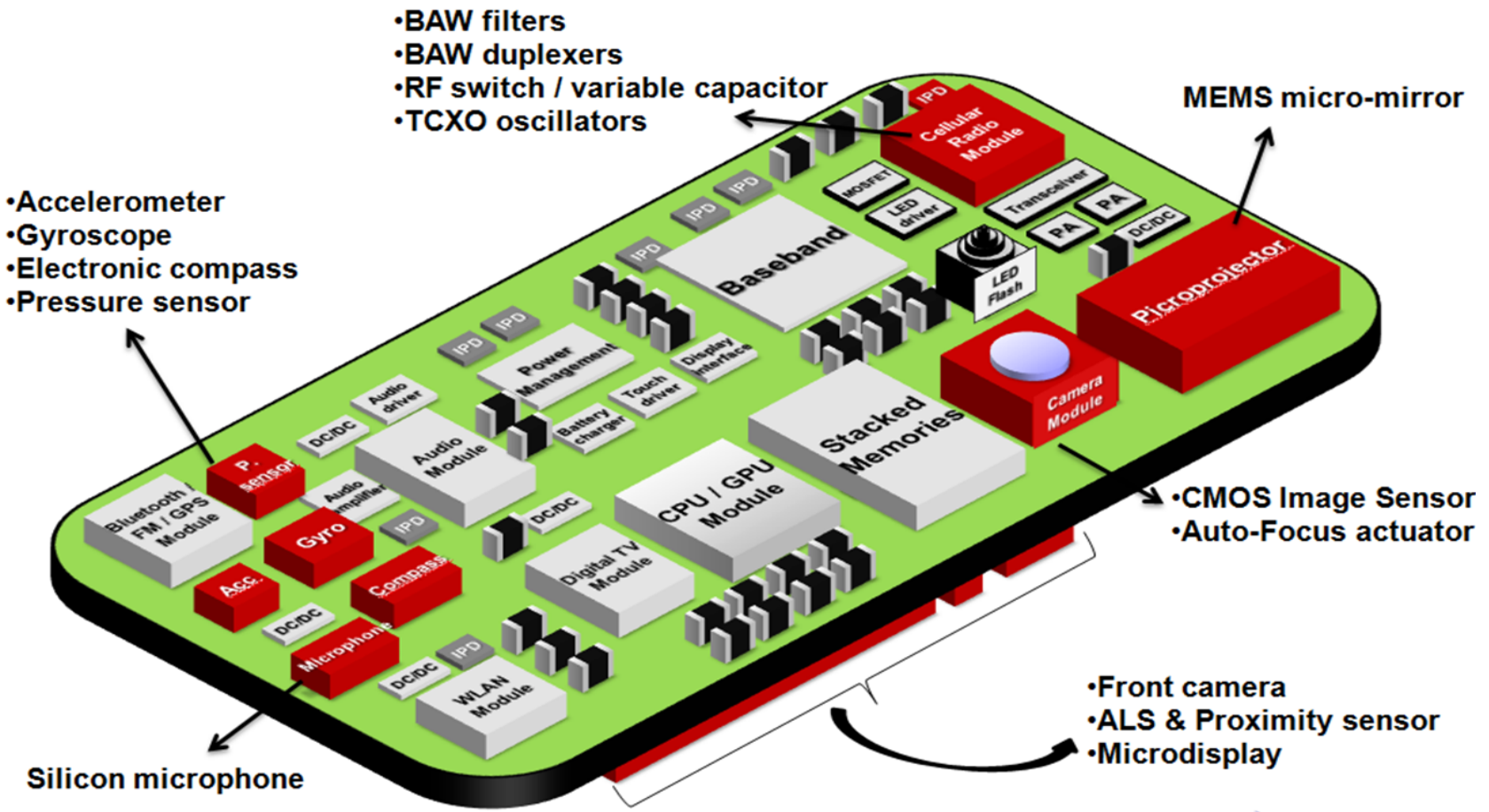
Integrated Circuits



Micro Electro-Mechanical Devices

Actvitity: Group Brainstorming List three sensors that are found on a high performance quadcopter or drone.

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Micro Electro-Mechanical Devices

Example 1: Magnometer and Digital Compass

An accelerometer is a tool that measures proper acceleration, which is the acceleration of a body in its own instantaneous frame.
Applications:

- Navigation Systems - Robotics - Aircraft - Missiles
- Personal Devices - Phones - Tablets
- Others:

Example 1: Magnometer and Digital Compass

Thought Exercise: How do we measure acceleration?

Actvitity: Group Brainstorming
Explain one method for measuring acceleration of a body.

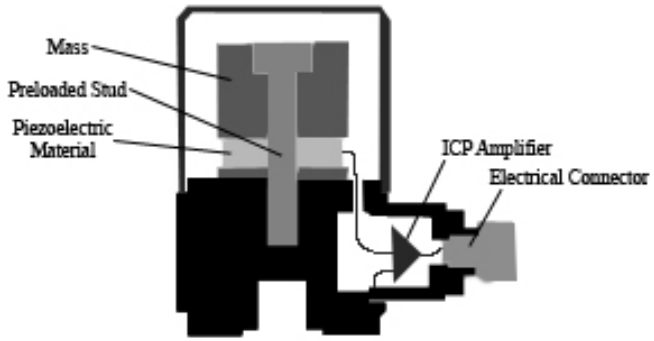
Example 1: Magnometer and Digital Compass

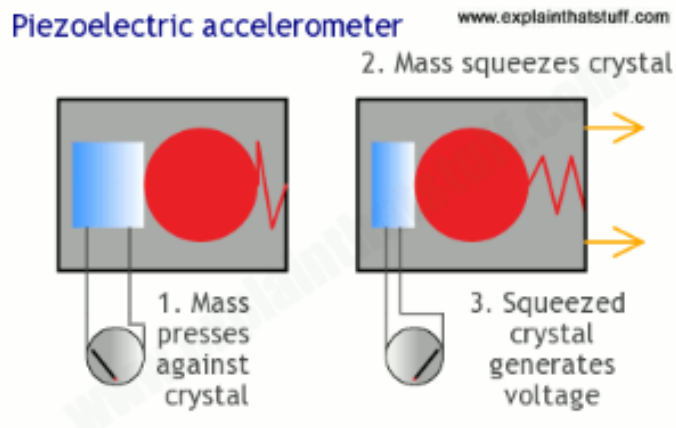
Mechanical Accelerometers Consist of a damped mass spring system and a sensing device.
Types of accelerometers:

- Seismometer or Seismograph
- piezoelectric - charge in material resulting from mechanical stress
- piezoresistive - change in resistance resulting from mechanical stress
- capacitive

Example 1: Magnometer and Digital Compass

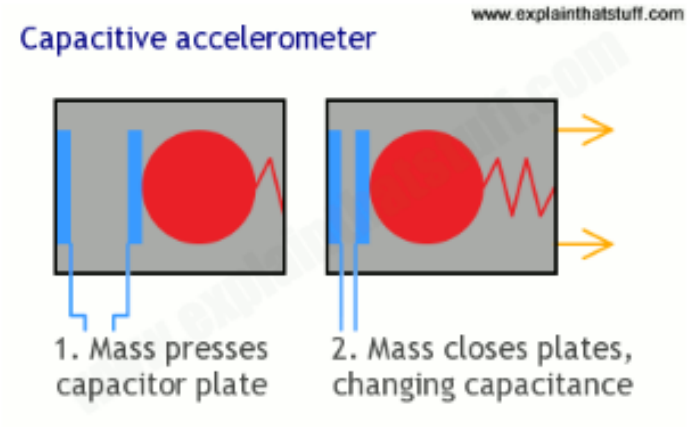
piezoelectric accelerometer





Example 1: Magnometer and Digital Compass

capacitive accelerometer



Example 2: Accelerometer

Thought Exercise: How do we measure orientation?

- What variable or quantity is used to describe motion?
  -
  -
  -
- What type of sensor is used to measure this?
  -
  -
  -

Example 2: Accelerometer

- What applications require this type of sensor?
  -
  -
  -

Example 2: Accelerometer